Internationalization, privatization and the reverse sequence[1]

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The traditional approach to science policy.

The traditional approach to science policy in developing countries has been to invest in a combination of good quality basic science and advanced technological projects in the public sector, with the hope that they will spread out to the rest of the economy and society. When specific problems are identified - in health, agricultural production, defense, communications, infrastructure - they may lead to the creation of mission oriented research bodies, with permanent staff and public funds. Complex policy-making bodies are created to coordinate all these initiatives, and international assistance is sought to improve the quality and provide resources for the system.

The results of this approach have not been very good. Public institutions tend to become bureaucratic, with rules of the civil service prevailing over scientific and technological goals. Even when quality is assured in a few institutions, projects and places, their broader impact in the economy and society is limited. At best, this traditional approach leads to the creation of a few high quality institutions and projects, with limited impact in their societies; at worst, it leads to the creation of interest groups formed by would-be researchers and science policy planners, demanding resources, receiving little, and not producing anything of relevance.

A common explanation for these difficulties is that, although the approach is right, the governments do not recognize the importance of science and technology and do not give the scientists and technologists a chance to prove their worth. The hope was that, on time, governments would come to realize the true importance of science and technology, and this situation would change for the better.

The fact, however, is that governments everywhere are facing the mounting costs of health, education and infrastructure, and are being forced to forsake long-range investments and programs, which include the science and

[1]Statememt prepared for the Round Table on "Internationalization et privatisation: une politque scientifique est-elle encore possible au Sud?", Colloque ORSTOM/UNESCO, Les Sciences hors d'Occident au XXeme Siecle, Paris, UNESCO, 19-23 September, 1994. Published in Roland Waast, editor, *Les Sciences Hors d'Occident au XXe Siècle*, vol. *6 - Les Sciences au Sud - État des Lieux*. Paris, ORSTOM éditions, 229-233.

technology sector. As the gap between science and technology in the South and the North increases, the demands for more resources for S&T in the South lose credibility, and the likelihood that governments will increase their concern for the needs of the S&T sector diminishes.

To this exhaustion of the traditional approach one should add the effects of two global trends, privatization and internationalization, and a new theory, based on the experience of the "Asian Tigers," that of the reverse sequence.

Privatization

The trend for the privatization of R&D results from a combination of two main factors. The first is the increasing role of science-based technologies in the production and marketing of goods and services. As science becomes more profitable, firms tend to invest more in R&D, and the products of their research is appropriated as patents and industrial secrets. The second is the end of the cold war, and the reduction of public expenditures in military research. The association between military and basic research was obvious in the developed countries, given the large resources given to the military to long-term, exploratory work, which often spilled over to the civilian and academic sphere as support for basic, non oriented research. The combination of these two factors is leading to a profound revolution on the ways scientific work is organized in developed countries, with the reduction and conversion of military research establishments, changes in the relationships between academic research and the private sector, and an ongoing revision of what means to be "a scientist," or "a researcher," in a modern society. Values such as long-term careers, free circulation of scientific knowledge, and the intellectual autonomy of the researcher are replaced by the search for short-term productions, proprietary knowledge and target oriented research; traditional peer review procedures give way to hard-nosed evaluation of results.

Internationalization

The trend toward internationalization is a consequence of the growing globalization of multinational corporations and institutions and the increasing speed and decreasing costs of international communications. As firms become global and the cost of communications tends to zero, flexibility in the spatial allocation of human and capital resources increases. One could make a car with the engines coming from Brazil, the electronics from Taiwan, the frame from Mexico, and the tires from Ghana. You can set up your research units in Cambridge, Massachusetts, or in Puebla, Mexico, or in São José dos Campos in Brazil. In principle, this trend could increase the spread of production activities

and research investments throughout the world. It could have, however, the opposite effect, through the concentration of resources and competencies in a few privileged locations.

The "reverse sequence."

The "reverse sequence" is a theory intended to explain and justify these changes, and it is based on the experience of Japan, Korea and the other "Asian Tigers." In essence, it challenges the conventional assumption that innovation flows from basic to applied knowledge, and then to industrial development and innovation at the shop floor. It is the reverse: first there is innovation, stimulated by market competition and the search for efficiency; as innovation becomes more complex and expensive, it requires special attention, resources and commitment. Next come the laboratories of industrial development, and, at the end, complex systems of basic research, to give support to everything else. According to this theory, if one starts with basic research and noncompetitive technologies, innovation would never materialize.

If this theory is correct, then the only justifiable science and technology policies are those directed toward improving the innovation capabilities of firms. Even here, direct investment and support for R&D can lead to market imperfections, over protectionism and waste. At the end, the only possible policies are those geared to the stimulation of market competitiveness. Applied to countries such as Brazil or Mexico, which developed sizeable scientific and technological establishments in the last two decades, the implication is that they should dismantle their research centers and graduate education programs, and start again at the other end of the sequence.

Flaws in the reverse sequence theory

The reverse sequence theory is conceptually flawed, and empirically doubtful. Given the high mobility of factors in the new internationalized environment, increased competitiveness tends to concentrate resources. Science and technological activities are attracted to places with numerous scientists and research facilities, and environments which are congenial to the researcher's lifestyles. Such environments are not the product of market competition, but of long-term investments in education, culture and social infrastructure.

The experience of scientific and technological development in Western countries is not that of the reverse sequence, but of the simultaneous development of basic and applied science, academic and non academic work, sometimes in cooperation, sometimes in conflict, sometimes in isolation from each other.

The more recent experiences of the "Asian Tigers" do not confirm the reverse model either. It is true that these countries invested little in basic and academic science, and put all their effort in strengthening their industry's innovation capabilities. But, without exception, they benefited from purposeful industrial policies, and large public investments in basic, secondary and technical education. One of the main differences between the Asian countries and those like Brazil or India that attempted policies of scientific and technological self-reliance was that, in the former, industrial policies were always directed toward increasing international competitiveness, rather than to the control of closed internal markets. Their industrial effort was fostered by private companies working in close cooperation and benefiting from strong and continuous support from their governments, in contrast with the state-owned, and usually inefficient industrial corporations in the latter; and their technological effort was geared toward the production of consumption goods and commodities, rather than toward highly sophisticated products with little marketability. Another common feature of the new Asian "tigers" was that all had strong and stable governments, in many cases with heavy involvement in cold war confrontations.

The new science policy for developing countries.

The conclusion from this reasoning is not that there is no place left for science policy in developing countries, but that this policy should be very different from what it used to be.

The main justification for such policy is that, in spite of the growing mobility of factors in the modern world, wealth flows to locations where competence, efficiency and life quality exist, and shuns places where they are absent. It pays, for a country, to invest in the education of its population, in the sophistication of its intellectual elites, in the provision of communication facilities, and in a clear and pleasant environment. Of course, it is still possible to profit from extensive agriculture or mining in poor and underdeveloped regions, from low wages paid to unskilled workers, or from monopolistic control of closed markets. But the wealth created in such conditions does not remain at its origin, and does not benefit local populations.

The new science policy should be conceived as part of this overall investment in education and quality of life. It should have clear and strong links with education at all levels - on the limit, research should be a by-product of teaching, and not the opposite. Secondly, a small but highly qualified community of persons working in the basic science is an important plus. Adequate social policy requires good social research, and the same applies, in a growing scale, to environment management. Industrial innovation depends on the availability of technical skills, and on the possibility to reach out to technical

expertise in universities, research firms and other places. Sound decisions on industrial investment require familiarity with the technological frontier, which depends on highly skilled researchers, and so on. In general, the presence of good quality, basic research enhances the intellectual climate of a country, brings fresh ideas through the links with the international community, and keeps the options open for the future.

To succeed, the new policy should avoid the pitfalls of the traditional approach. It should not let ambitious technological projects to go awry for the lack of macroeconomic or strategic sense; it should not allow bad quality, unproductive research institutions to proliferate, and absorb the available resources in routine activities. It should abandon the pretenses of comprehensive, long-range planning and their corresponding bureaucracies, and replace them with pragmatic, light and high quality decision mechanisms.

At the end, the main problem with the science policies of developing countries is not that they lost relevance because of the new conditions of privatization and internationalization, and the new conceptions about the reverse sequence. The main problem was that these policies led often to the creation and maintenance of low quality (but often expensive) research. If this situation could be changed, by making the research activity more responsive to the requirements of education and industrial innovation, and more competitive internationally, then there is still a place for science, and for policies designed to foster it.